EIGHTH INTERNATIONAL CONFERENCE ON
SYNCHROTRON RADIATION INSTRUMENTATION

ACCEL

Superconductive mini-gap undulators – a new way to high energy photons: Latest news

S. Kubsky[1], D. Dölling[1], A. Geisler[1], A. Hobl[1], U. Klein[1], D. Krischel[1],
H.O. Moser[2] ,
R. Rossmanith[3], S. Chouhan[3]

[1]ACCEL Instruments GmbH, Bergisch-Gladbach, Germany
[2] Singapore Synchrotron Light Source, National University of Singapore
[3]ANKA, Karlsruhe, Germany

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Content:

- General interest in Superconducting (sc) undulators
- Accessible parameter range (B; K; ª; g)
- Sc-undulator for SSLS (NUS) / Characteristics
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- Magnetic measurements: ACCEL‘s experimental setup
- First magnetic measurements of NUS - undulator
- Example of spectral performance in a medium energy ring (SOLEIL)
- Technical perspectives for forthcoming devices

Mini-gap superconducting undulators

<u>Goals:</u>

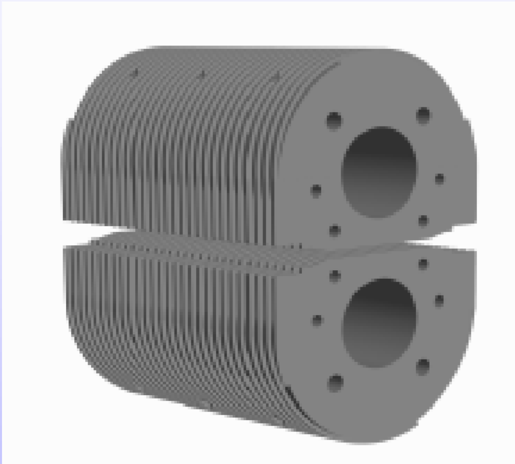
- Sharp spectrum for low heatload on beamline optics and high brilliance in variable spectral regions of interest

- High-energy photons *and* high brilliance possible for medium-energy storage rings (see simulated spectra)

- <u>Choice of parameters:</u>

  Tunability: Harmonics 1 and 3 should overlap,
  => gap: 4-5 mm; $k \approx 2$ if $\lambda \approx 14 - 15$ mm

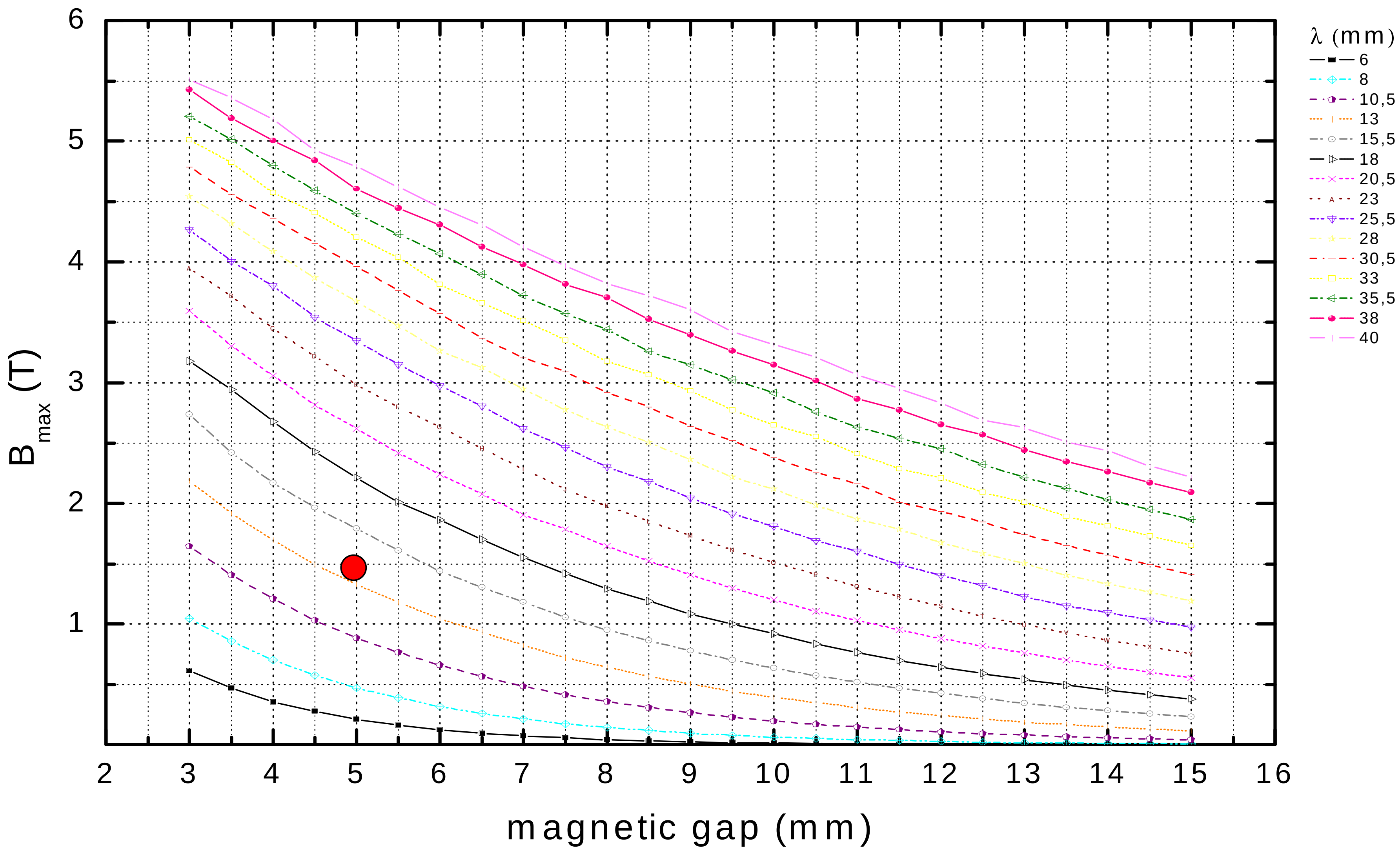
- Low phase error for FEL and for efficient use of higher harmonics



Prototype undulator (Mock-up)

Accessible parameter range
(B, K, a, magn. gap)

The geometry of the conductors (not taken into account here) may lead to different values, so this graph is to give an idea about feasibity of a parameter set. The loadline (~80%) has been considered.



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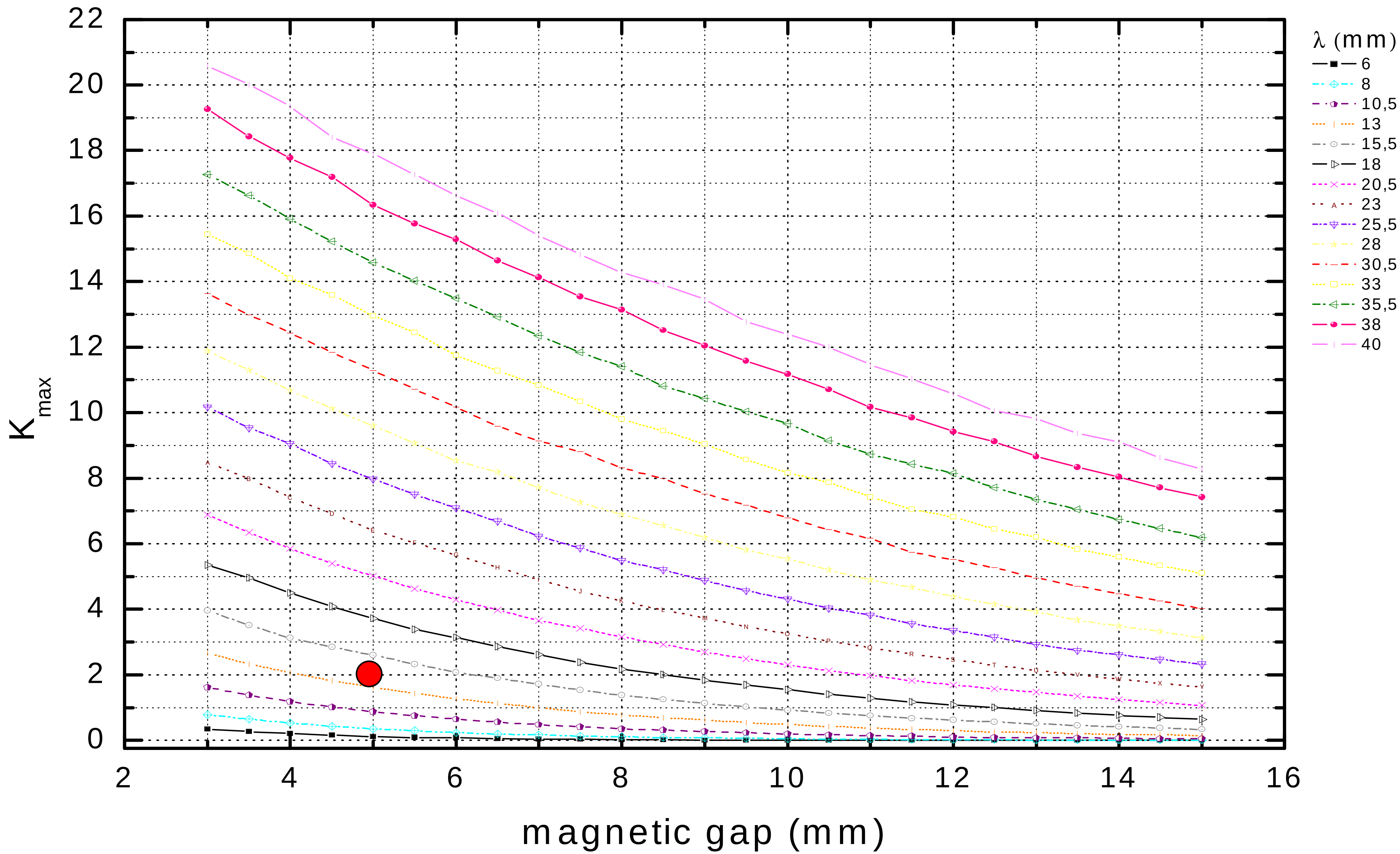

Sc-undulator for SSLS (NUS) / Characteristics

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NUS-undulator after winding

<u>Technical specifications and design criteria:</u>

- Period length ª = 14 mm
- Number of periods = 50 => magnetic length = 70 cm
- $B_{max.}$= 1.3 T @ 80% of sc-loadline
- Superconducting NbTi-coils
- Cryogenic concept: Cryogen free system (GM-cryocoolers)
- Power consumption <= 30 kW
- Delivery to customer in 2003

Systematic quality control

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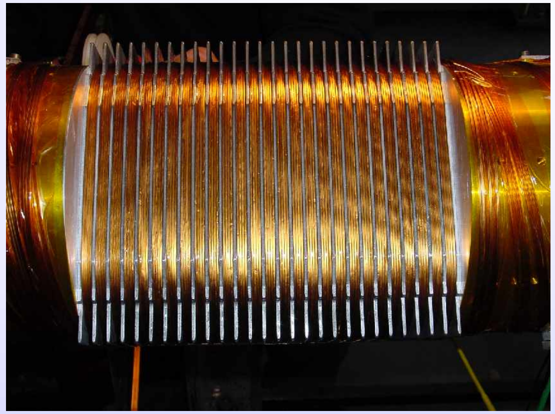
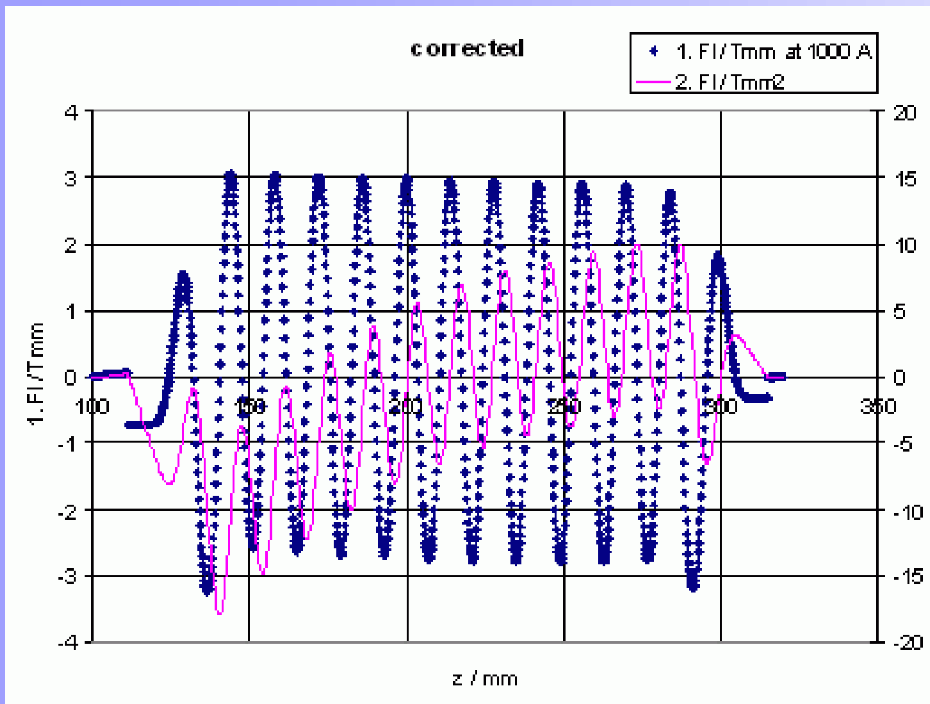
- Each production step is followed by a verification of tolerances prior to continuation
- Several steps of simulation serve to compare the actual production status to design specifications
- Magnetic precision can be measured before the coldmass is mounted in its cryostat
- Integral measurements by ACCEL prior to delivery or even on site will be available soon

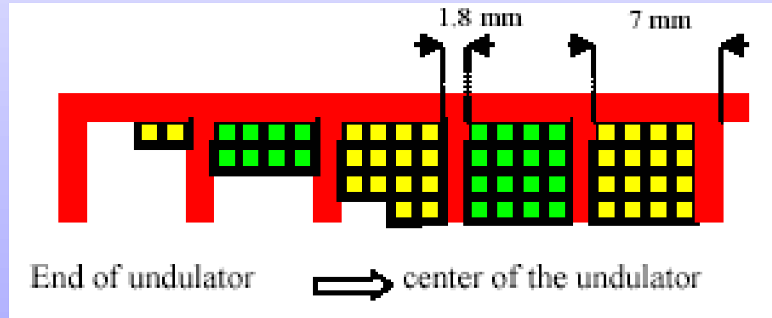
„Mock-up“ Prototype

- 10 Periods
- a = 14 mm
- Gap = 5 mm
- $B_{max.}$= 1,4 T @ 80% of sc-loadline
- K = 1,8
- End-pole correction



„Mock-up“ prototype; 10 periods





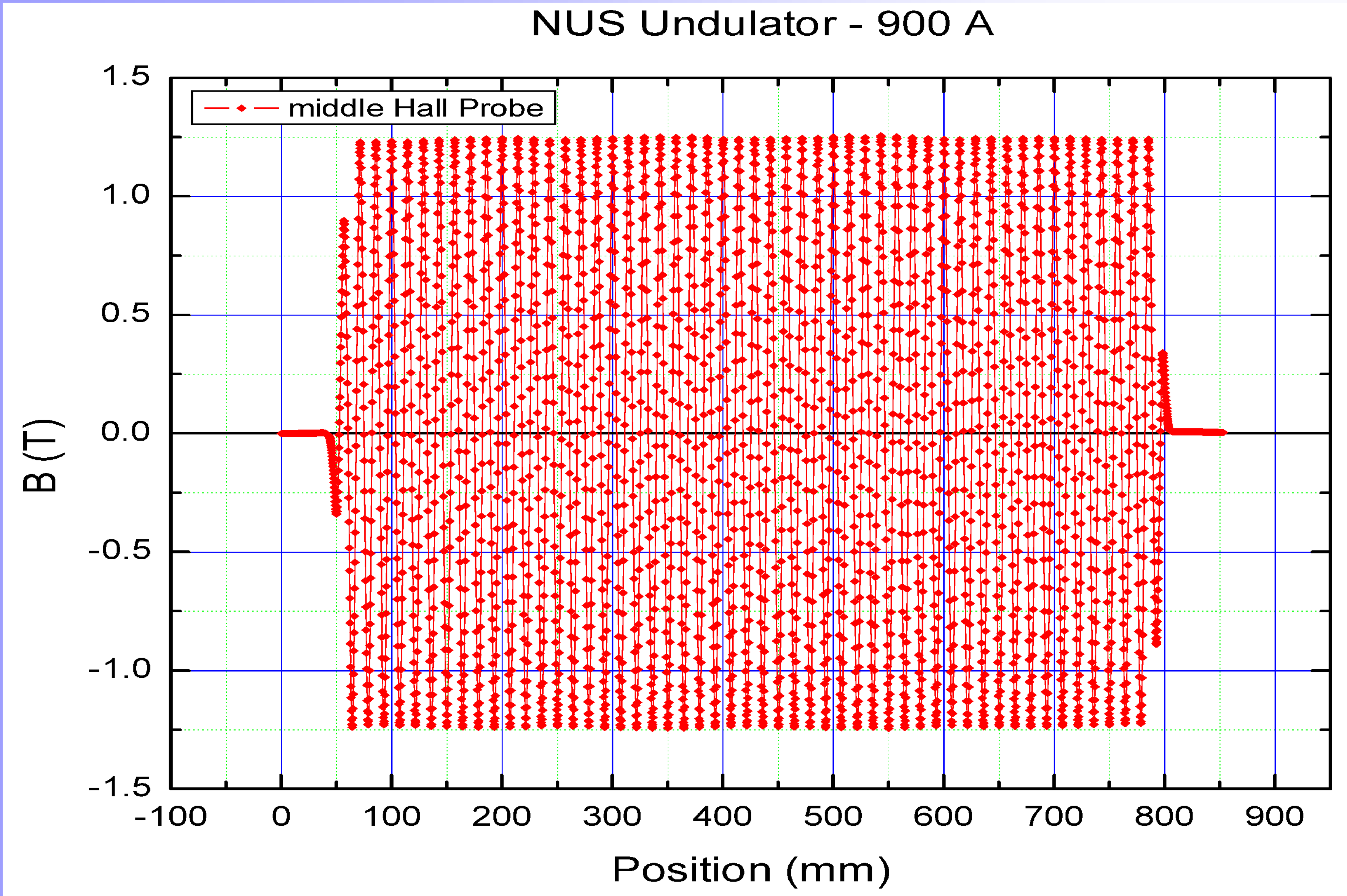
End field-correction

First and second field integral derived from Hall probe measurement with mathematical correction (2 steerers and one dipole)

First Magnetic measurements: Experimental setup

- Calibrated Hall probes (@ 4K) for magnetic field measurement
- Simultaneous readout of pick-up coils
- Continuous / discrete probe movement modes
- Variable speed
- Position control by adapted optical methods

First magnetic measurements of NUS - undulator



First magnetic measurements of NUS - undulator

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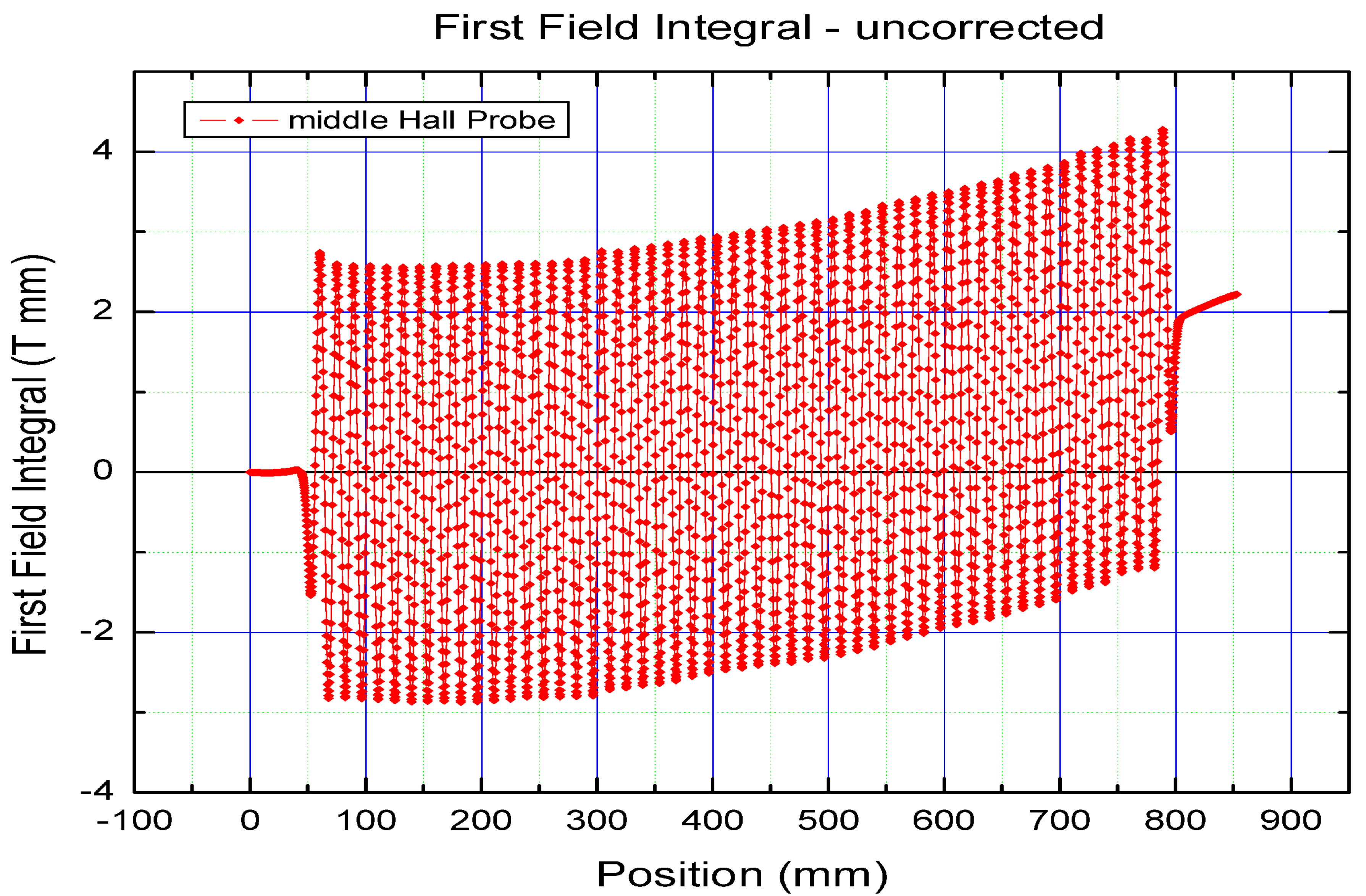

First magnetic measurements of NUS - undulator

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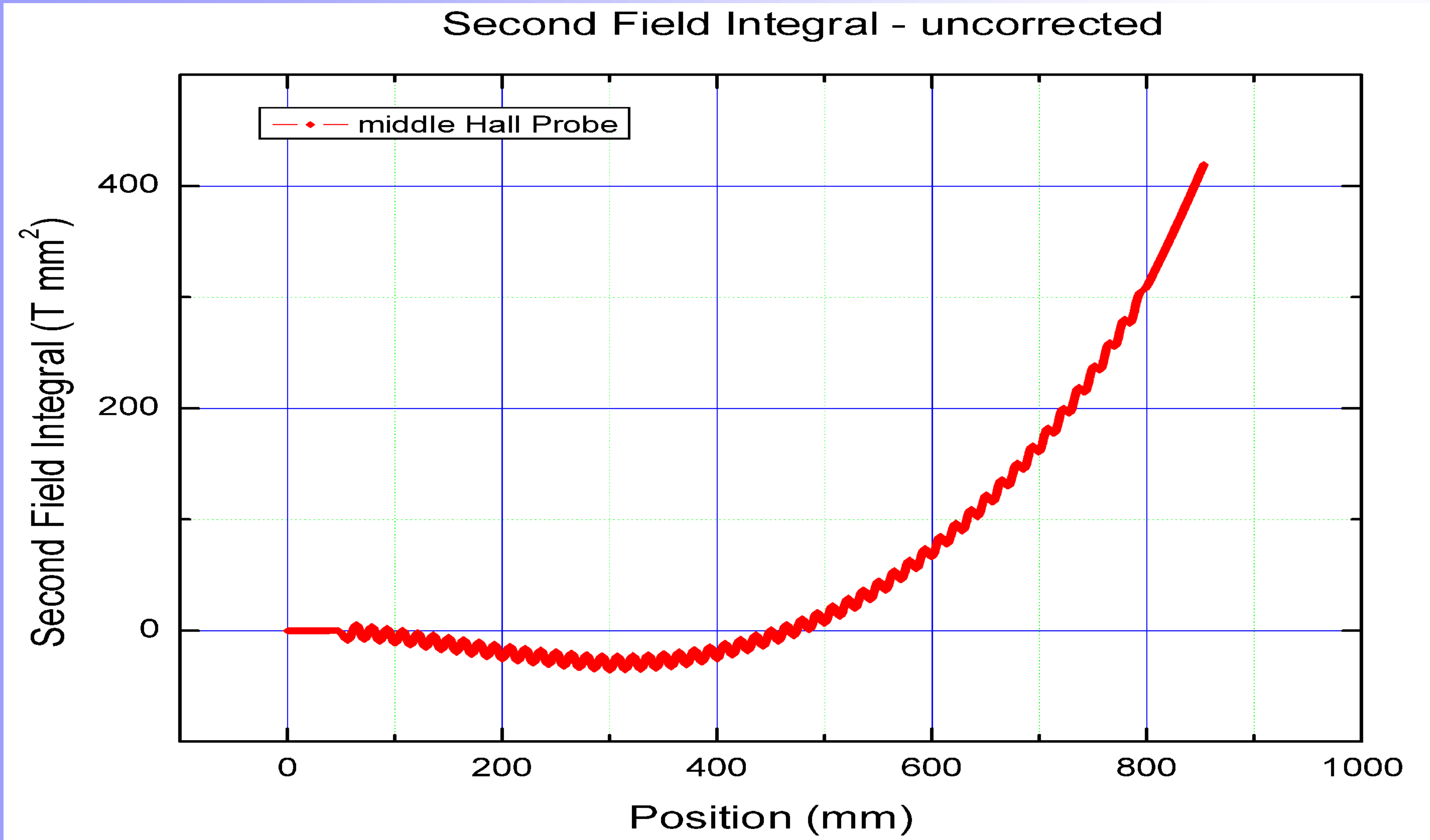
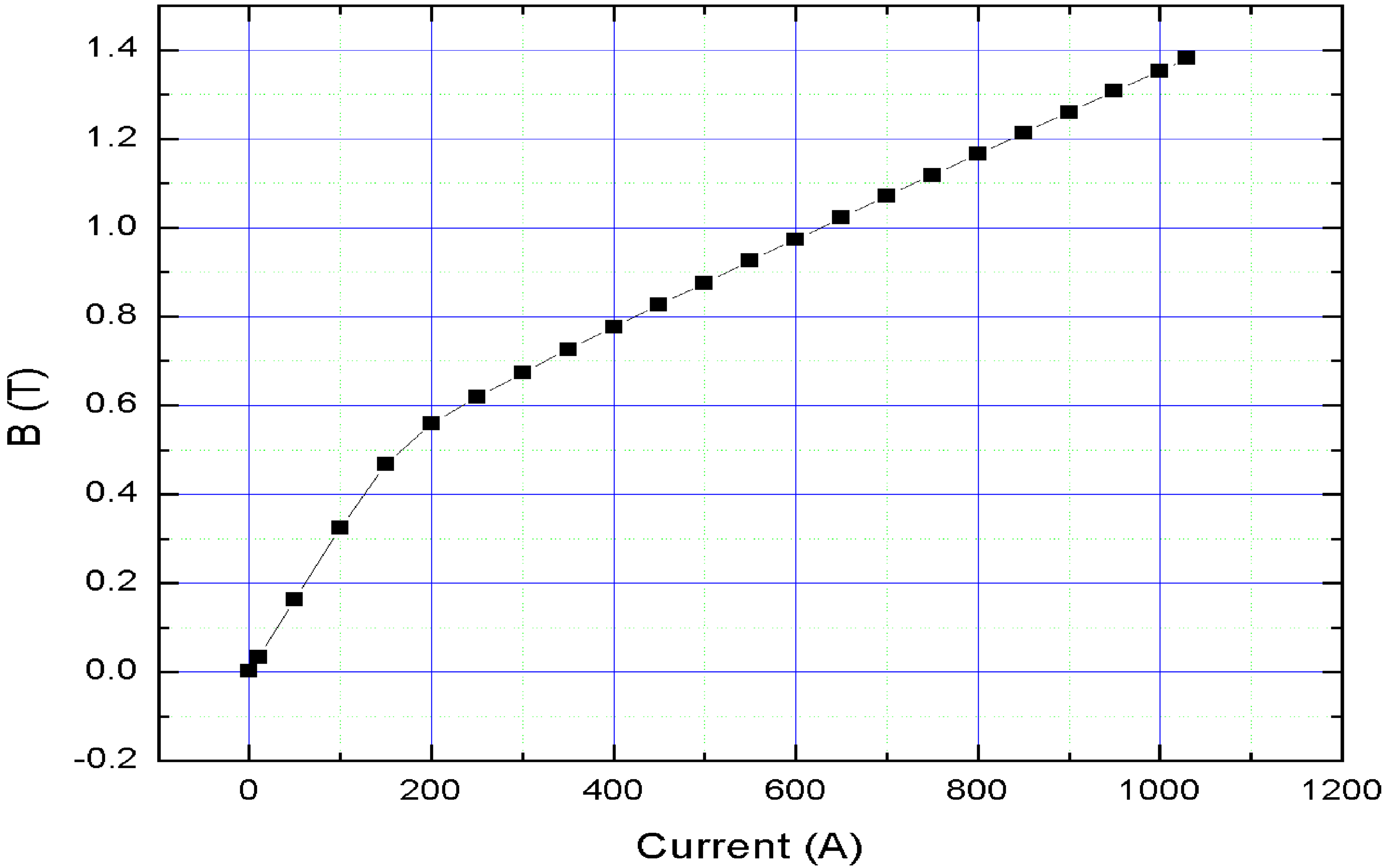


- **Minimum field error for NUS-device is 5.6° rms**

First magnetic measurements of NUS - undulator



Example of spectral performance - Flux

(Simulation of ANKA-undulator in SOLEIL - storage ring)

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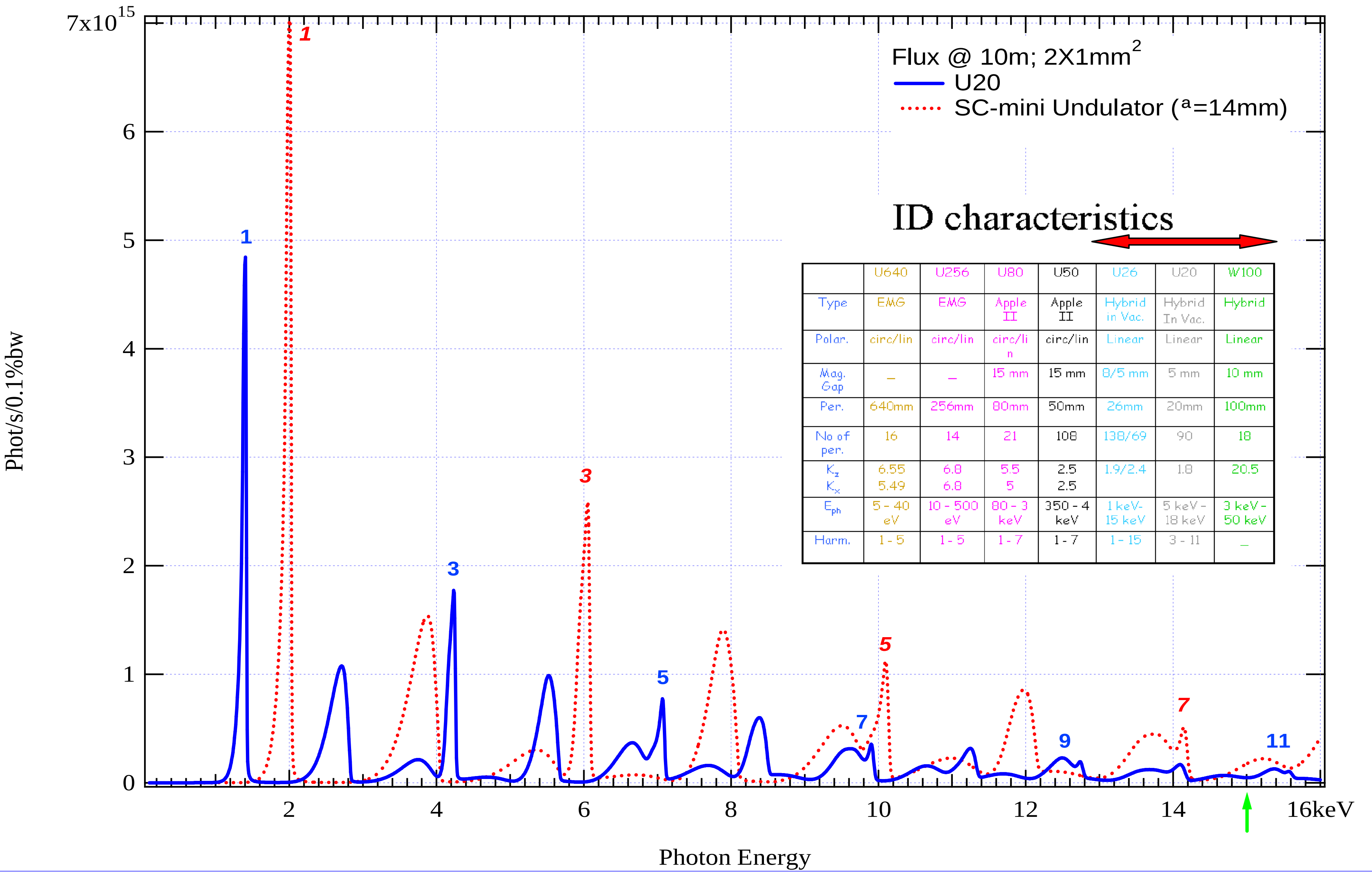

ID characteristics

	U640	U256	U80	U50	U26	U20	W100
Type	EMG	EMG	Apple II	Apple II	Hybrid in Vac.	Hybrid In Vac.	Hybrid
Polar.	circ/lin	circ/lin	circ/lin	circ/lin	Linear	Linear	Linear
Mag. Gap	_	_	15 mm	15 mm	8/5 mm	5 mm	10 mm
Per.	640mm	256mm	80mm	50mm	26mm	20mm	100mm
No of per.	16	14	21	108	138/69	90	18
K_z K_x	6.55 5.49	6.8 6.8	5.5 5	2.5 2.5	1.9/2.4	1.8	20.5
E_{ph}	5 - 40 eV	10 - 500 eV	80 - 3 keV	350 - 4 keV	1 keV- 15 keV	5 keV - 18 keV	3 keV - 50 keV
Harm.	1 - 5	1 - 5	1 - 7	1 - 7	1 - 15	3 - 11	_

Example of spectral performance - Brilliance

(Simulation of ANKA-undulator in SOLEIL - storage ring)

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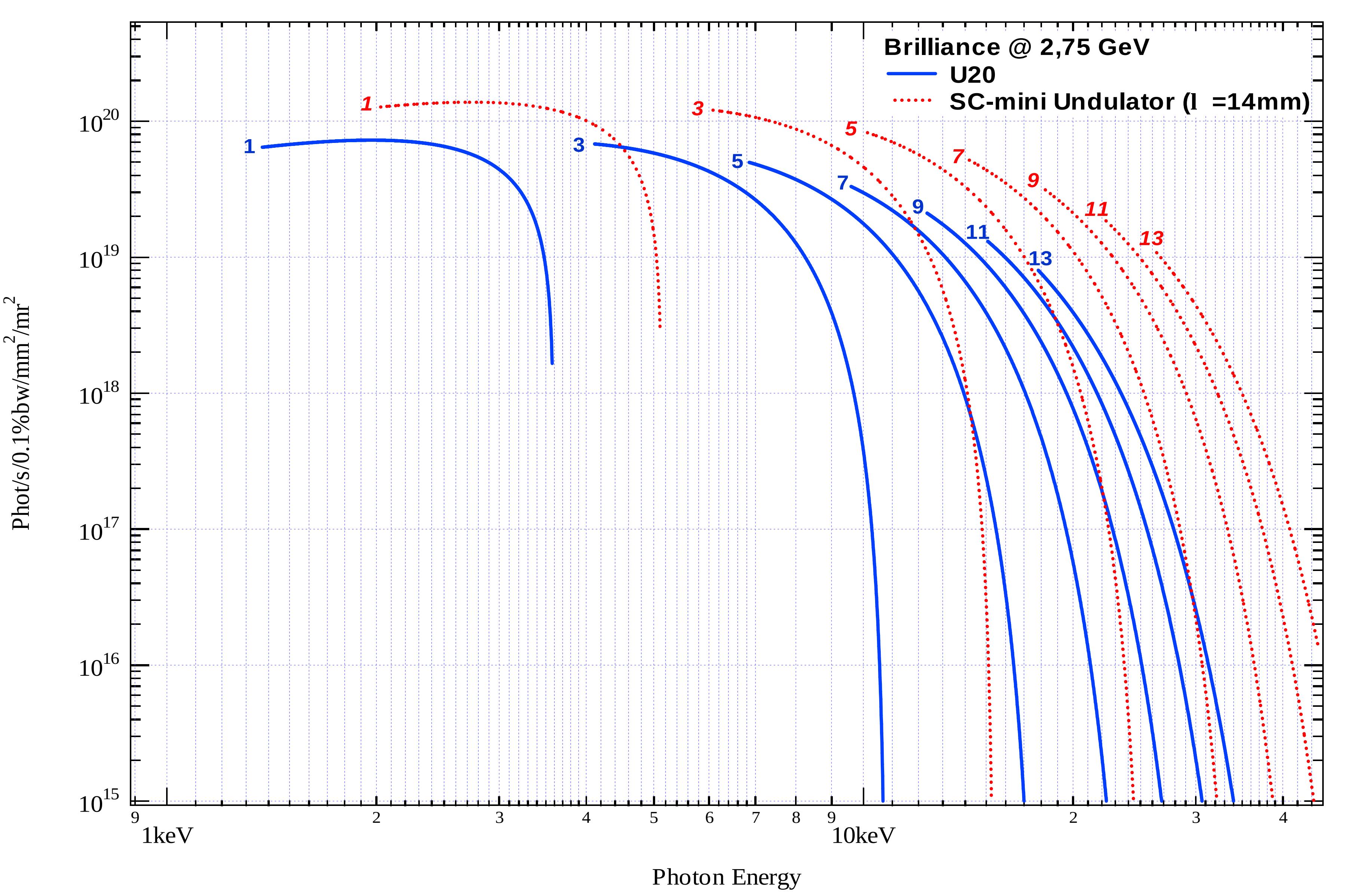

Technical perspectives for forthcoming devices

- Global tendency for smaller dynamic apertures makes mini-gap insertions devices more suitable for applications in storage rings
- Cryogen-free concept
- Variable gap option (during B~0T) holds for pursuit of technical achievements on the machine side (mini-gap) and flexibility concerning users demands
- ACCEL‘s development of exact magnetic measurements for sc-IDs validates for usage in applications demanding a low phase error
- Higher device lengths are under technical investigation (e.g. FEL – applications)